MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 3, 2016/2017

DET5028 – INDUSTRIAL ELECTRONICS

(Diploma in Electronic Engineering - All sections/groups)

30 MAY 2017

9:00 AM – 11:00 AM

(2 HOURS)

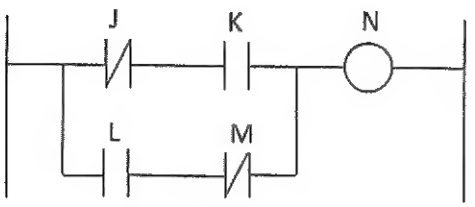
INSTRUCTIONS TO STUDENT

1. This question paper consists of **6** pages with **5** questions.
2. Answer **ALL** questions. All necessary working steps **MUST** be shown.
3. Write all your answers in the answer booklet provided.

QUESTION 1 [20 marks]

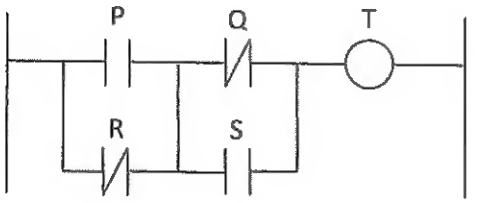
(a) Provide the logical function for each of the following PLC programs by using AND/OR/NOT operators.

(i)



[5 marks]

(ii)



[5 marks]

(b) By using a 30-s timer and a counter, design a PLC ladder diagram that will turn on a motor 5 minutes after a switch is turned on. The counter can be manually reset using a pushbutton. The timer will self-reset every time.

The answer should be drawn into a single ladder diagram only.

[10 marks]

Continued...

QUESTION 2 [20 marks]

(a) *Figure 2-1* shows the switching configuration of a bi-directional motor-control circuit. Explain the bi-directional control of motor that makes use of the double-pole, double-throw (DPDT) switch.

[6 marks]

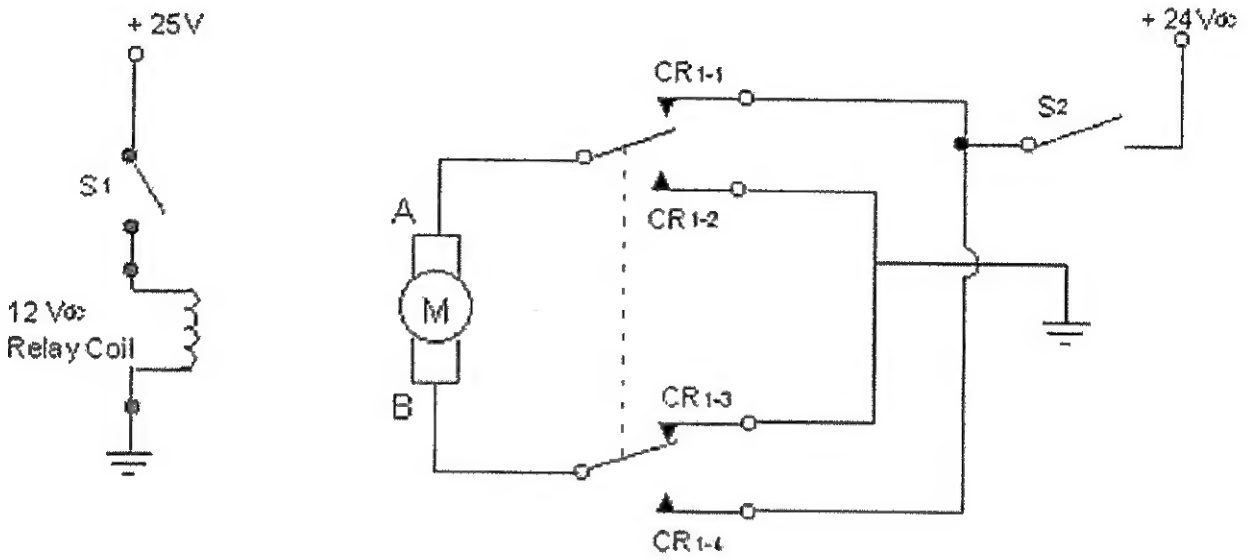


Figure 2-1

(b) Refer to the circuit shown in *Figure 2-2*. Given that,

r_{BB} = 12 kΩ, r_{B2} = 3.5 kΩ, V_{dc} = 12 V, $V_{EB1(sat)}$ = 2 V, I_P = 2 μA, I_V = 2 mA, R = 20 kΩ, and C = 0.02 μF. During the discharge phase, r_{B1} = 100 Ω.

Continued...

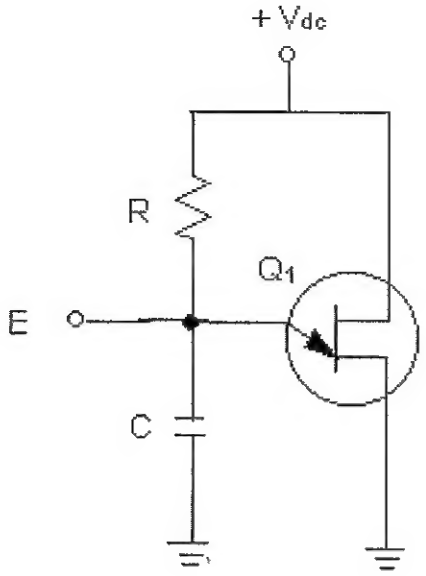


Figure 2-2

(i) Determine the intrinsic-standoff ratio.

[4 marks]

(ii) Calculate the necessary voltage required to turn on the UJT.

[3 marks]

(iii) Determine the frequency of oscillation.

[7 marks]

Continued...

QUESTION 3 [20 marks]

(a) Give the definition of a sensor and a transducer.

[4 marks]

(b) An RTD with $R_T = 250\ \Omega$ is placed in a measuring circuit where $F_{SH} = 0.01$ °C/mW. The temperature coefficient of resistivity is $\alpha = 0.004$ /°C and the resistance of the sensor is 100 Ω at 0 °C.

(i) Find the resistance value at 75 °C.

[2 marks]

(ii) If the self-heating error is to be limited to 0.2 °C, determine the maximum voltage that can be used in the circuit.

[6 marks]

(iii) Find the new resistance value of the RTD due to its self-heating problem.

[4 marks]

(c) A strain gauge has an indicator wire whose strain is $\varepsilon = 270\ \mu$ with a gauge factor of 3.2. The wire's initial length was 0.6 m and its original resistance was 250 Ω. Find the **total change in length** of the wire and **total change in resistance** after it is strained.

[4 marks]

Continued...

QUESTION 4 [20 marks]

(a) State any two reasons for the application of proximity sensors.

[4 marks]

(b) An optical shaft-encoder has 80 slits on its optical disc. The gear ratio is 5 between the large-diameter gear and the disc. It also has a direction-indicating ability. Its output is a 9-bit signed magnitude binary, with the 9^{th} bit on the far left representing either sign bit 0 for positive (disc rotating clockwise), or 1 for negative (disc rotating counter clockwise).

(i) What is the transducer's resolution?

[2 marks]

(ii) What is the maximum allowable shaft motion to ensure that the counter never exceed its capacity?

[4 marks]

(iii) If the measured shaft moves 2/5 turn in clockwise rotation, what is the content of the binary counter?

[3 marks]

(iv) If the measured shaft moves 225° in counter clockwise rotation, what is the content of the binary counter?

[3 marks]

(v) What direction and amount of shaft movement represented by a binary output of 1 1010 1010?

[4 marks]

Continued...

QUESTION 5 [20 marks]

(a) Mechanically, DC motors consist of the armature and the field poles. Explain the parts that make up the armature assembly.

[3 marks]

(b) For a shunt-configured DC motor, given that the field winding resistance is 153 Ω and the motor terminal voltage is 230 V, answer the following questions:

(i) Calculate the field current.

[2 marks]

(ii) If a 200-Ω rheostat is added to the shunt field circuit, calculate the range of adjustment of the field current.

[3 marks]

(iii) Refer to part (i), if the total current is 7.8 A, how much current flows in the armature circuit?

[2 marks]

(iv) Assume that there is an increase in the mechanical drag on the motor shaft, and it causes more current to be drawn from the DC supply, such that the total current is 12.2 A, what is the new value of the armature current?

[2 marks]

(v) If the armature winding resistance is 2.8 Ω and the armature current is 6.3 A, how much CEMF is being generated by the armature?

[2 marks]

(vi) From part (v), if CEMF decreases to 200 V, how much current flows in the armature loop?

[2 marks]

(vii) Sketch the equivalent circuit for a shunt-configured DC motor.

[4 marks]

End of Page.